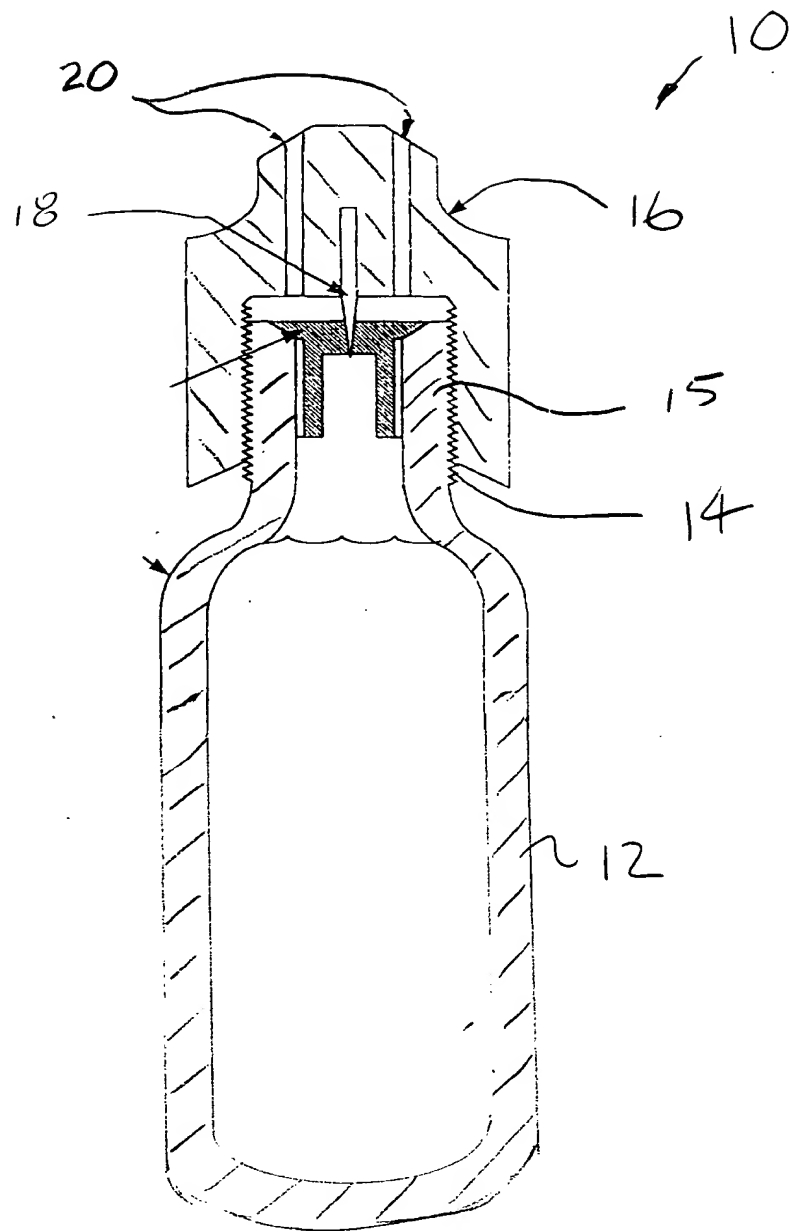
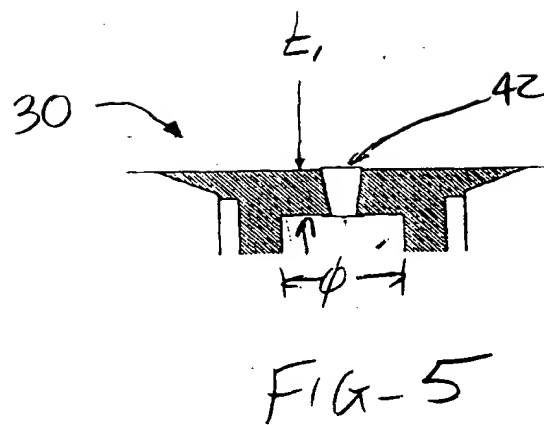
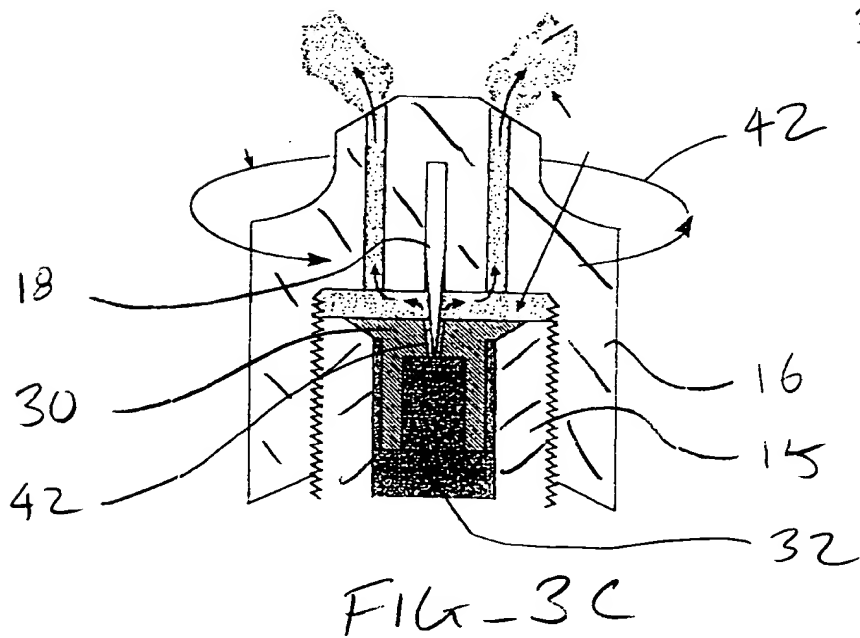
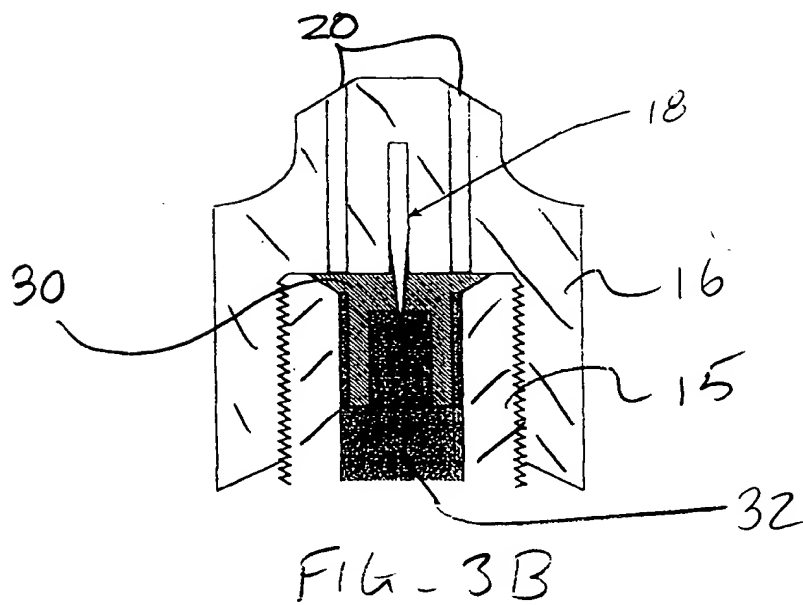
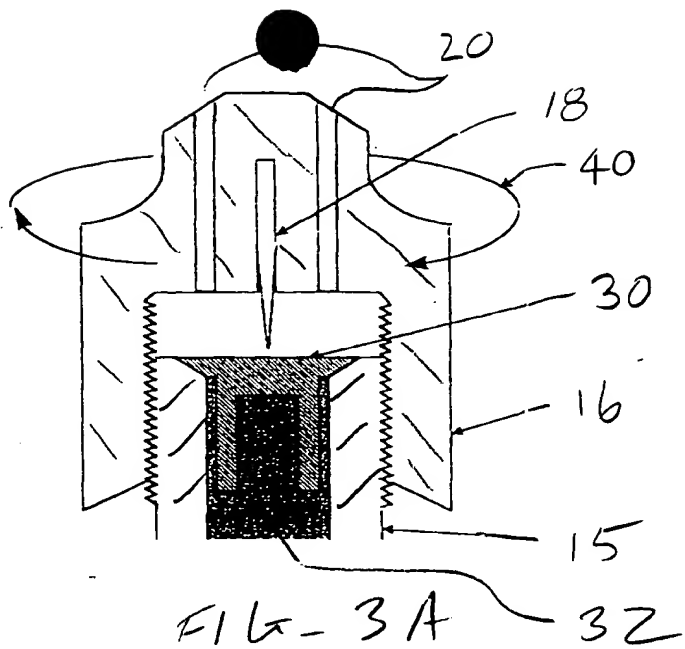


FIG - 1



FILE-2



002120" 08E11560

Fig. 4A

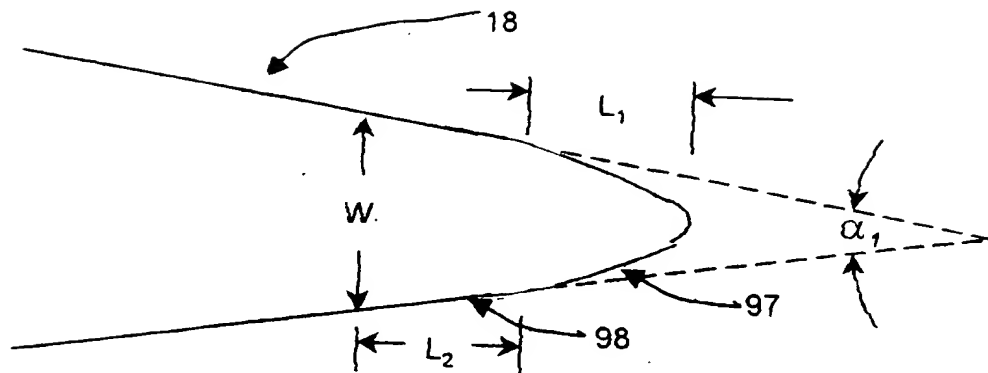


Fig. 4B

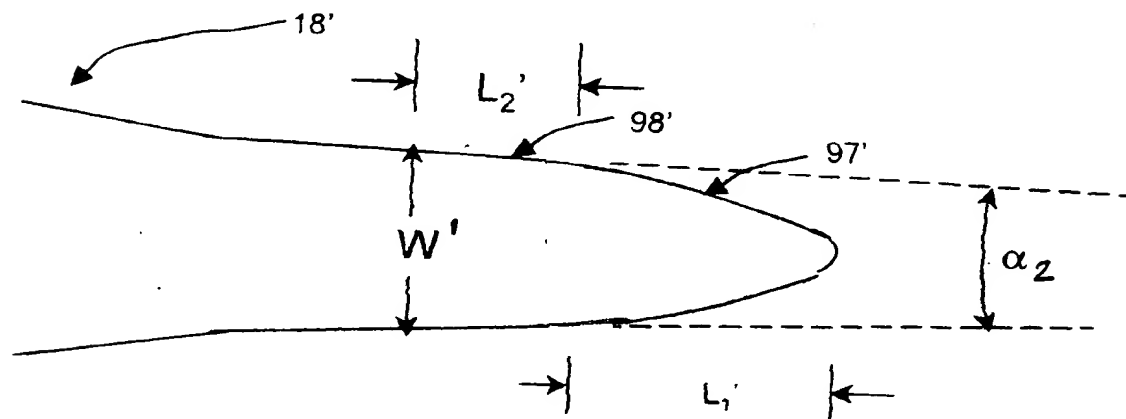
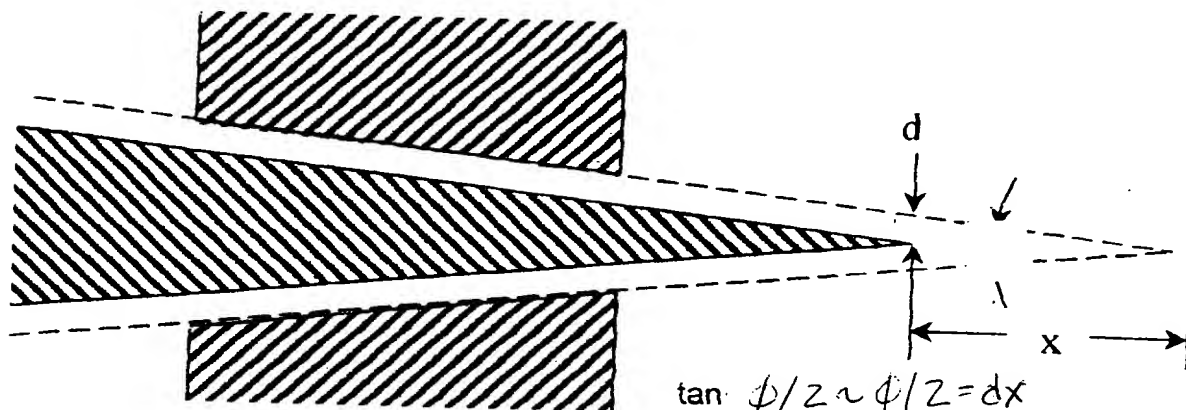
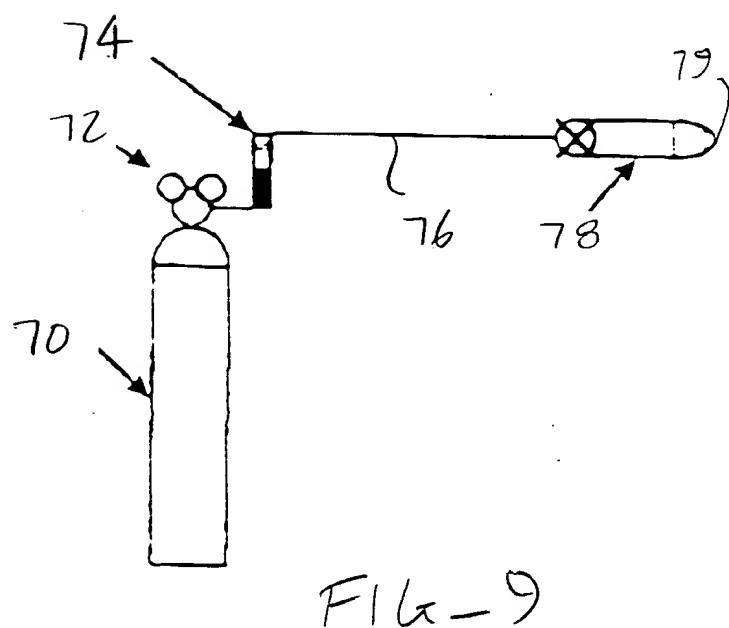
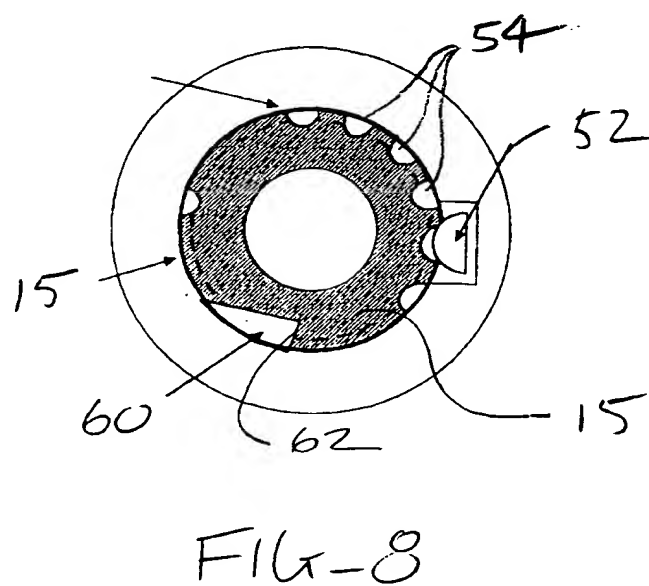
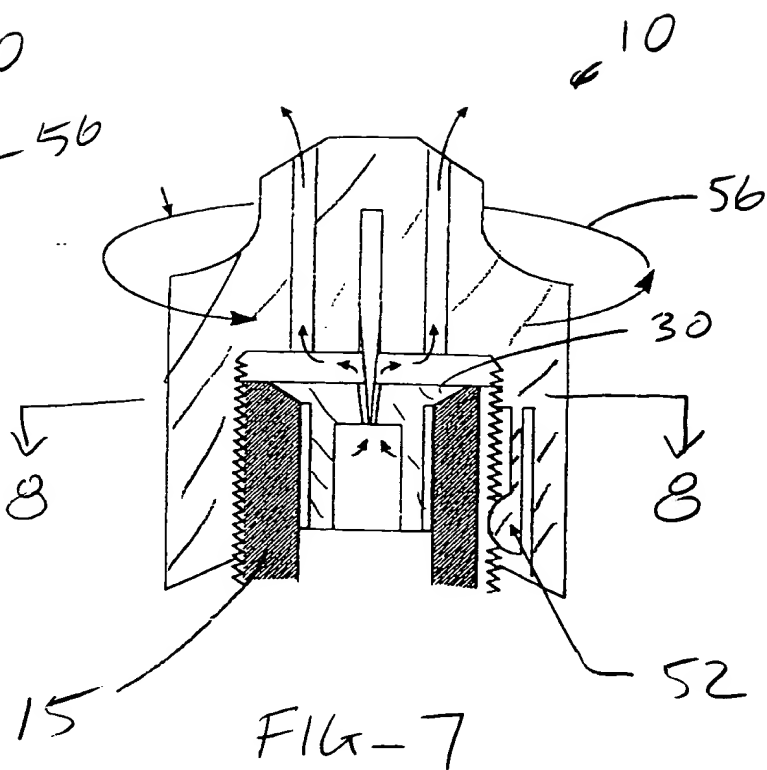
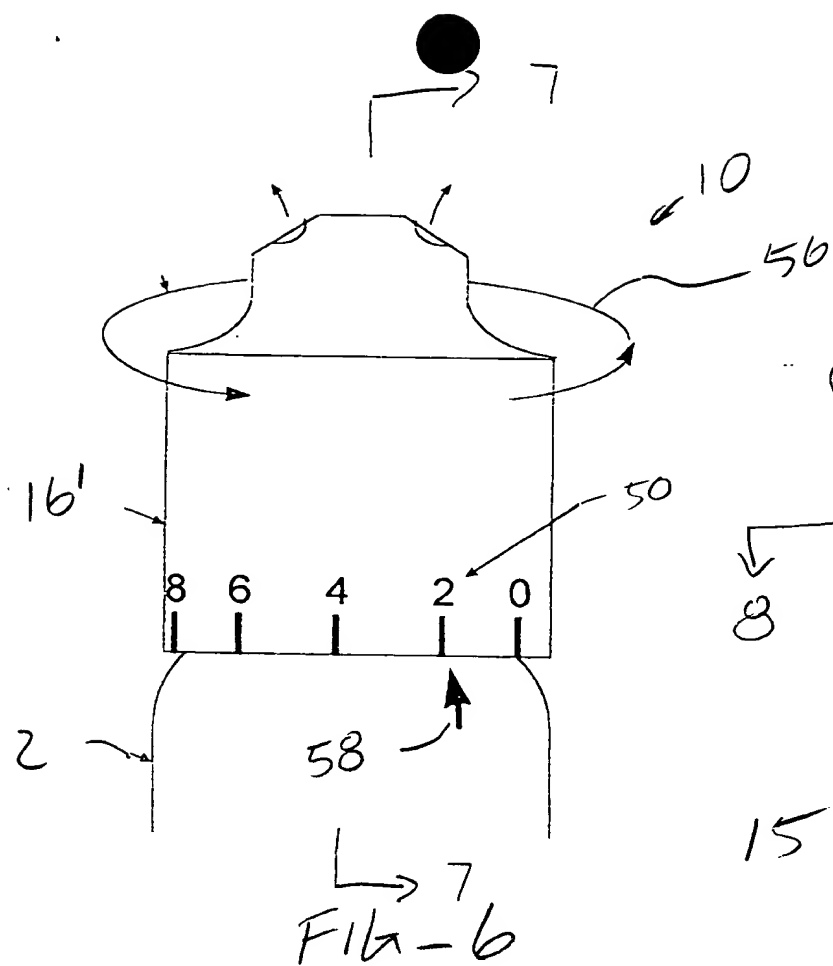


Fig. 4C



$$\begin{aligned} \tan \phi/2 &\sim \phi/2 = dx \\ d &\sim \phi x/2 \\ \phi &\sim 2 d/x = 115 d/x \text{ deg} \end{aligned}$$



002720 002720 002720

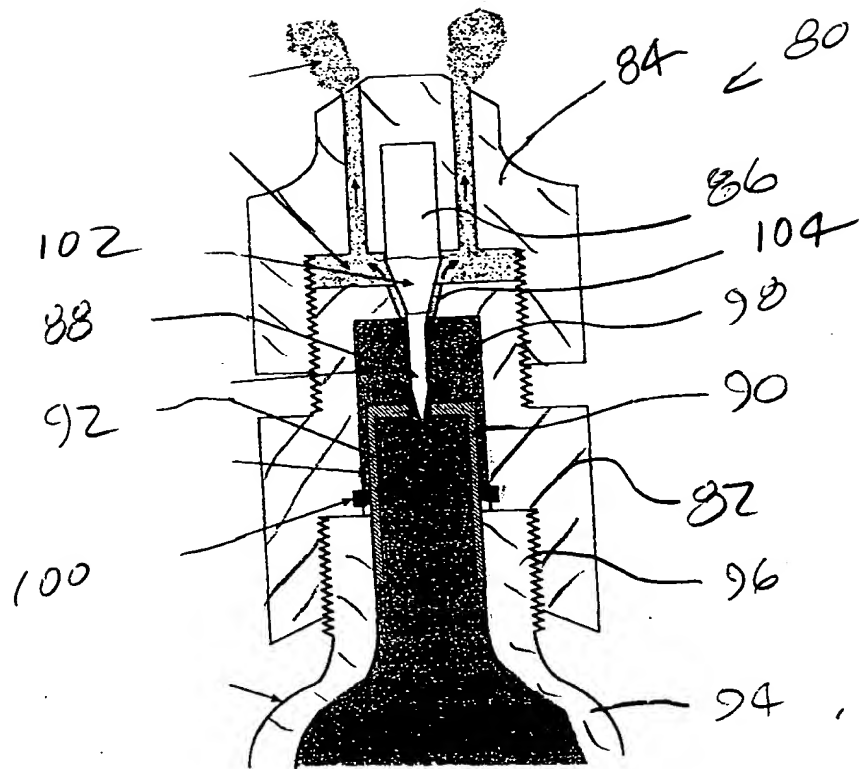


FIG- 9A

002120" 002120" 002120"

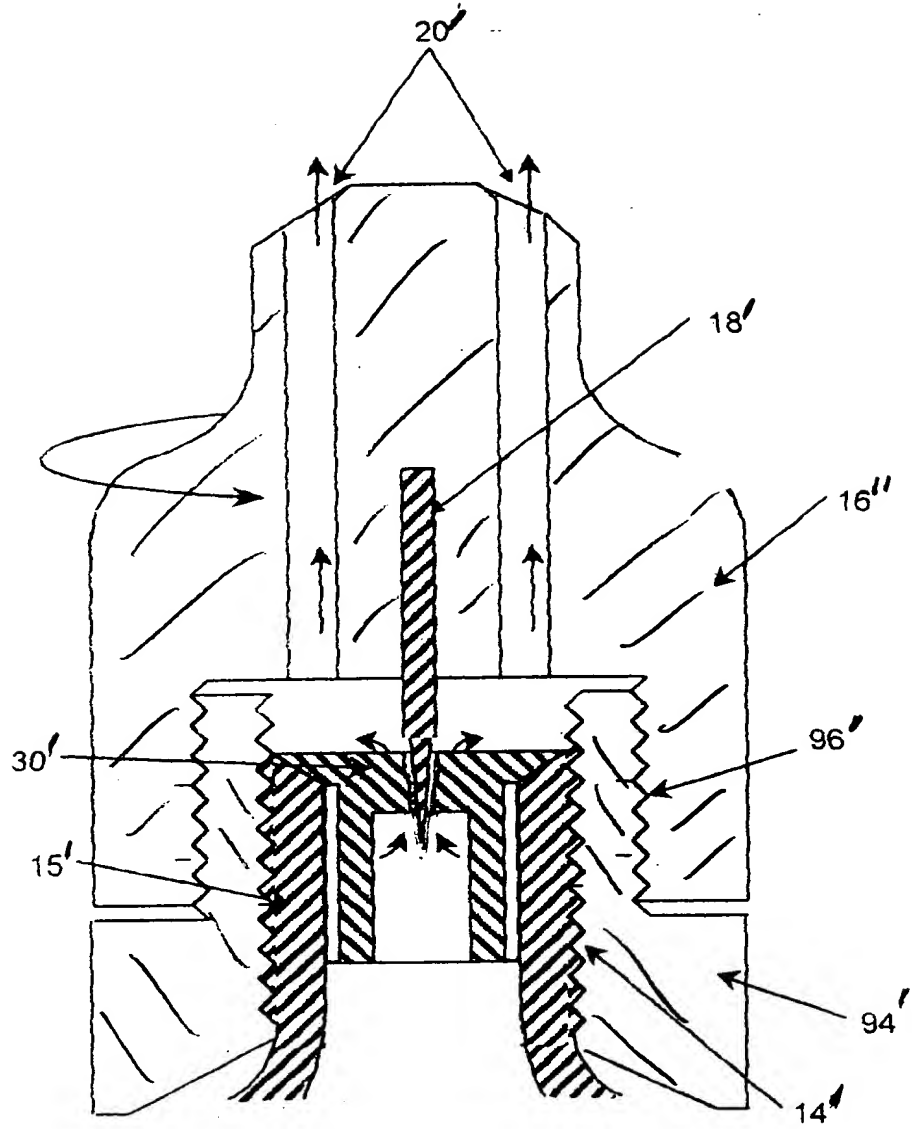


FIG - 9B

00644300 074200

120 →

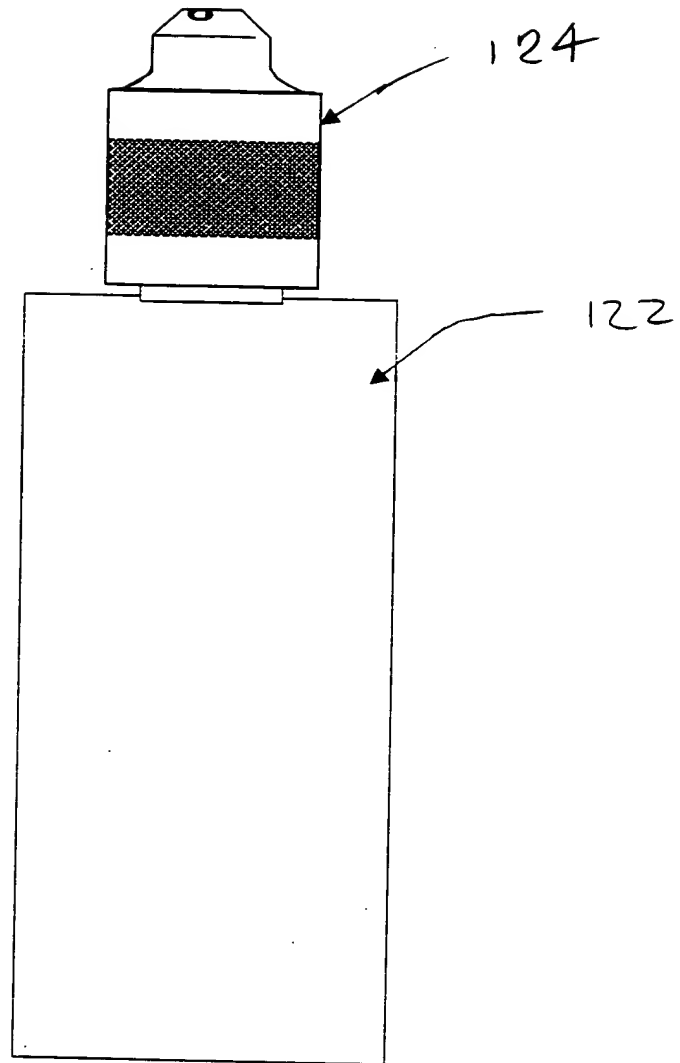


FIG-10



140 →

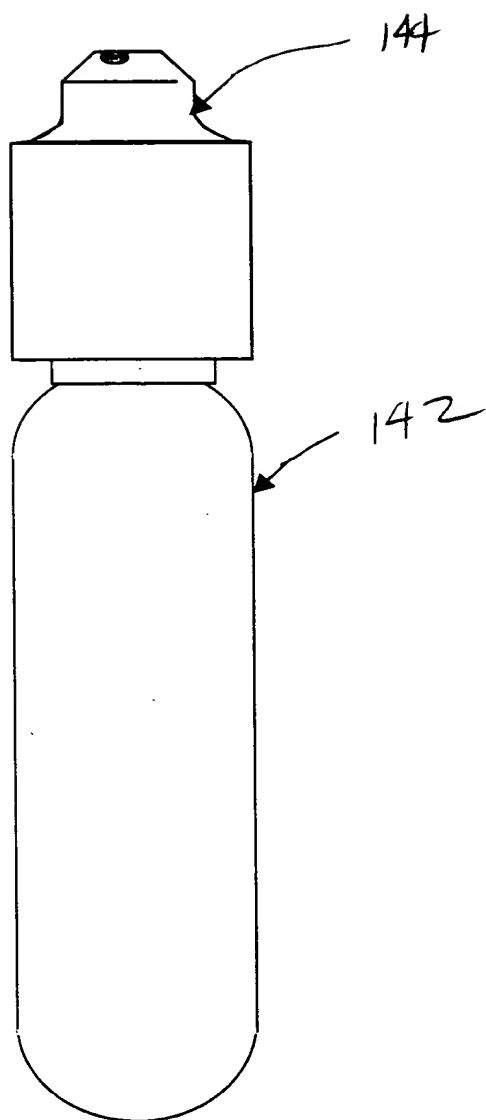


FIG-11

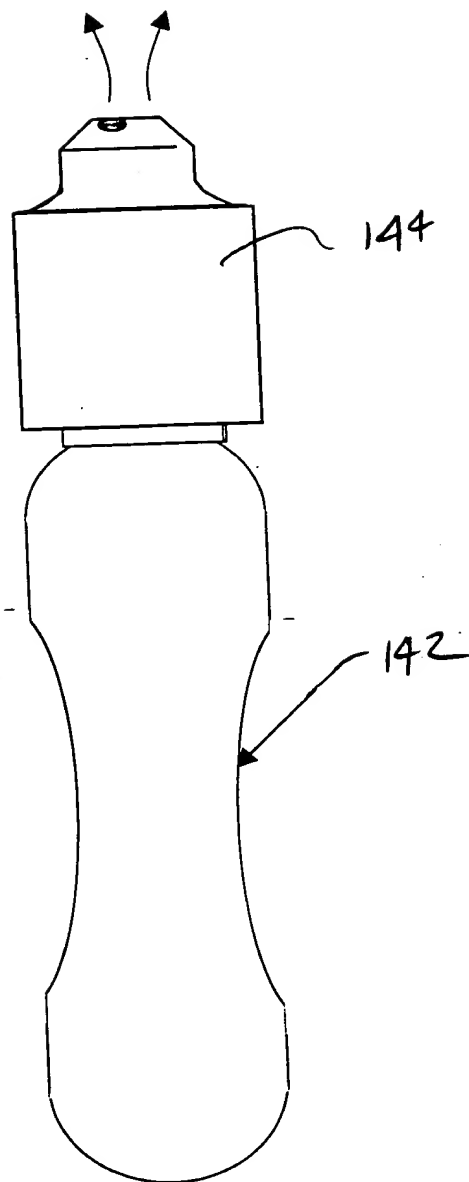
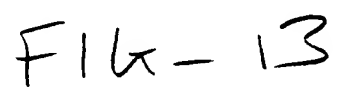


FIG-12

# THE 1970s



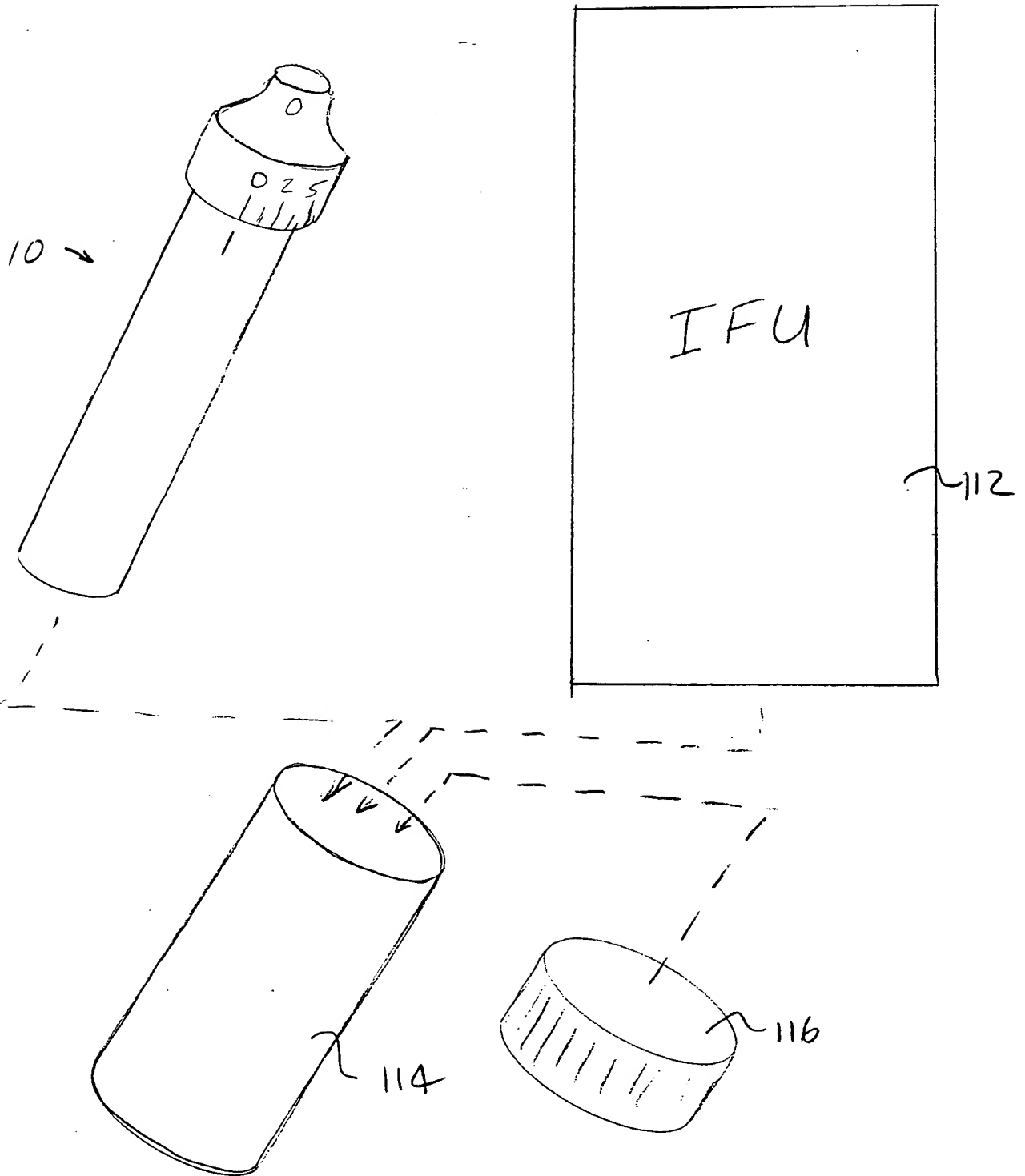


FIG. 14

A graph showing Flow Rate (CC/SEC) on the Y-axis (0 to 10) versus Head Rotation Angle (DEGREES) on the X-axis (0 to 300). The graph compares experimental data points (open circles) with three theoretical models:

- INITIAL NEEDLE**: A vertical dashed line at approximately 10 degrees, representing a model where flow starts immediately at a small angle.
- 1-piece model with 28 threads/inch**: A solid curve that starts at approximately 40 degrees and rises steeply, reaching a flow rate of 10 CC/SEC at approximately 250 degrees.
- 2-piece model with 48 threads/inch**: A solid curve that starts at approximately 40 degrees and rises more gradually than the 1-piece model, reaching a flow rate of 10 CC/SEC at approximately 250 degrees.
- PREFERRED NEEDLE**: A solid curve that starts at approximately 40 degrees and rises more gradually than the 2-piece model, reaching a flow rate of 10 CC/SEC at approximately 250 degrees.
- Unseating hysteresis**: A small loop in the data at low head rotation angles (below 100 degrees), indicating a difference in flow rate between increasing and decreasing head rotation angles.

The graph shows that the flow rate increases with head rotation angle, and the preferred needle model (2-piece model with 48 threads/inch) provides the best fit to the experimental data.

FIG - 15